Chapter 5
Water, Water Everywhere

What is the most important resource on Earth? Water! Think of it: Almost everything we do involves water, from the food we eat to brushing our teeth. We use a lot of water, but there is a fixed amount of water on Earth and in its atmosphere. What makes this possible is that water is recycled through Earth's water cycle, the *hydrologic cycle*. Though 71 percent of our planet is covered by water, people can't use most of it because it is seawater, frozen at the poles, or deep underground. Only 0.003 percent of all water on Earth is clean, fresh water that is usable. As Earth's population continues to grow, clean water is becoming a limited resource. How we care for our water influences our daily lives, affects life on land and in the oceans, and shapes our future on Earth.

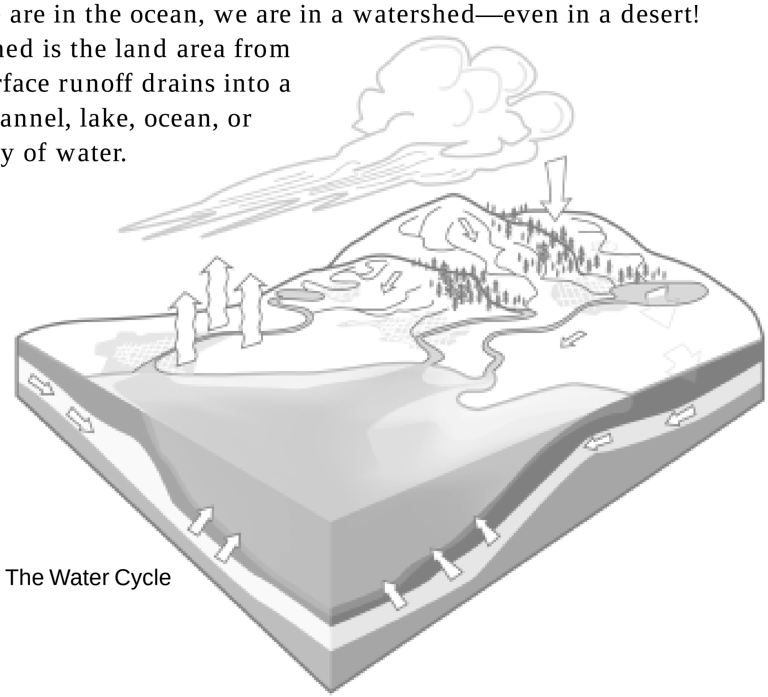
Water on Earth moves between the atmosphere, land, and oceans in a journey known as the hydrologic or water cycle. Water falls from the atmosphere as snow, hail, or rain onto land and ocean. The sun's heat provides energy to evaporate water from Earth's surface water (oceans, lakes, etc.). Plants also lose water to the air in a process called transpiration. The water vapor eventually condenses, forming tiny droplets in clouds. When the clouds meet cool air over land, precipitation in the form of rain, sleet, or snow is triggered, and water returns to the land or sea. Some of the precipitation soaks into the ground. Some of the underground water is trapped between rock or clay layers; this is called groundwater. But most of the water flows downhill as runoff, eventually returning to the sea.

New Words
watershed; hydrologic cycle (water cycle), point and nonpoint source pollution

Water travels over land through *watersheds*. Wherever we are on Earth, unless we are in the ocean, we are in a watershed—even in a desert! A watershed is the land area from which surface runoff drains into a stream channel, lake, ocean, or other body of water.

California Coastal Commission Area of Critical Concern: Water Quality and Wetlands

Relevant California Science Content Standards, Grade 5: Earth Sciences 3.a, d, e



The Water Cycle

Grade 5 Activities

These activities focus on water: its sources, cycles, and uses. Students will gain an appreciation of this valuable and limited resource, learn from where their domestic water comes, and learn actions they can take to conserve it.

Activity Goals

5.1. A Drop in the Bucket

Students will:

1. Calculate the percentage of fresh water available for human use.
2. Explain why water is a limited resource.

5.2. Alice in Waterland

Students will:

1. Trace their domestic water to its source prior to human use and to its destination after use.
2. Identify potential effects from human water use on terrestrial and aquatic wildlife.
3. Develop and practice responsible water conservation behaviors.

5. 3. Branching Out!

Students will:

1. Predict where water will flow in watersheds.
2. Describe drainage patterns in watersheds.

Tracking water from its source, to its uses, to where it ends up helps us understand why water is a precious resource, especially in California. In the northern part of our state, we have little summer rain to replenish water supplies that are drained by use over our dry summers. The southern half of our state is relatively dry year round, and does not receive much rain in the winter or spring, either. Water from northern California is transported to southern California via the California Aqueduct and the Central Valley Project. This water comes from snow runoff from the interior mountain range, the Sierra Nevada.

Water—how much there is, and how clean it is—is one of the biggest issues we Californians will face in the future. Available water will determine our daily water use habits, what we eat, how much we pay for it, where we go for vacations, and where we live. We need to manage our use of clean water so there is enough to maintain wetlands and natural places, for agriculture, home use, for electricity, and to support business and industry. There are many things we can do to make sure that water entering wetlands and the ocean is not harmful to the plants and animals that live in these habitats, and we can learn about ways that we can keep the water clean in rivers, lakes, and the ocean.

What happens when we don't take care of our water?
Polluted runoff, watersheds, and wetlands!

Polluted water reaches coastal streams, wetlands, and our oceans from both *point sources* and *nonpoint sources*. Point sources are those that can be traced back to a particular place, usually an outlet or pipe from a stationary location, where pollution is dumped or discharged into a body of water. Because point sources originate from one particular place, there typically are just one or a couple of kinds of pollutants introduced to the water.

Nonpoint source pollution, on the other hand, comes from many diffuse sources across the land. It originates when rainfall, snowmelt, or irrigation runoff flows over the landscape and picks up pollutants as it heads for larger water bodies. These pollutants might consist of oils and greases, metals, bacteria, trash, pesticides, or other contaminants depending on the areas the water runs over before reaching the ocean. In agricultural areas, pesticides, sediments, and nutrients are the prime types of pollution for wetlands, waterways, and the ocean. Runoff in urban areas carries oil dripped from cars, trash, plastics and pet waste from the streets and sidewalks, and an assortment of chemicals (detergent, lawn fertilizer, paint, insecticides) from every day life.

When pollutants enter wetlands and oceans they can harm the plants and animals that depend upon clean water to live. Luckily, there are plenty of things people and cities can do to prevent nonpoint source pollution and to provide for healthy oceans in the future. We can practice wise water use, watch what we put down household drains and storm drains, and be aware of the chemicals we use in gardens—every little effort goes a long way. See page 55 for more tips.

Grade 5 Activity

Science skills
- Calculating
- Predicting
- Inferring
- Graphing

Concepts
- Though nearly three-fourths of Earth is covered with water, there is a finite amount of water on Earth.
- Very little (.003 percent of the total amount of water on Earth) is potable.
- Contamination of fresh water resources reduces the amount of water available for all life.

California Science Content Standards
Earth Sciences

3. Water on Earth moves between the oceans and land through the processes of evaporation and condensation. As a basis for understanding this concept, student will know:

3.a. Most of Earth's water is present as salt water in the oceans, which cover most of Earth's surface.

3.d. The amount of fresh water located in rivers, lakes, underground sources, and glaciers is limited and that its availability can be extended by recycling and decreasing the use of water.

3.e. Students know the origin of the water used by their local communities.

Activity 5.1
A Drop in the Bucket

Earth is a water planet, but when you break down the percentages, there isn't much clean water for us to use.

Background

Ironically, on a planet extensively covered with water (71 percent), this resource is one of the main limiting factors for life on Earth. The "Water Availability Table" in this activity summarizes the major factors affecting the amount of available water on Earth.

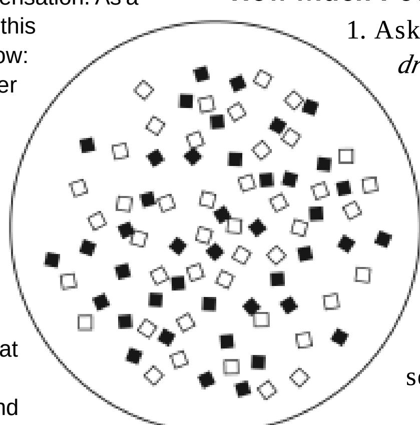
If all the clean, fresh water were distributed equally among all people, there would be about 1.82 million gallons (7 million liters) per person. While this is a large amount per individual, it is only about 0.003 percent of the total amount of water on Earth—not very much in the big picture.

For some, water may appear to be plentiful, but for others it is a scarce commodity. Why are some people in need of water while others have more than they need? Where you live and how you use water makes the difference. Geography, climate, and weather affect water distribution. Agriculture, industry, and domestic use affect availability.

The water we drink and use every day comes from our watershed. In the U.S., 61 percent of our population relies on lakes, rivers, and streams as our source of drinking water. The other 39 percent rely on groundwater that they pump from the ground.

This activity is broken into two sections: In *How Much Potable Water Is There?*, students predict the proportion of potable water on Earth; and *A Drop in the Bucket* is a teacher-led demonstration of the surprisingly small amount of potable water on Earth.

Activity 5.1a
How Much Potable Water Is There? Predict!



1. Ask students "What is 'potable' water?" (*Water suitable for drinking.*) What are some undrinkable waters? Students are to predict the proportion of potable water on Earth compared to the rest of the water on the planet. Students work in small groups (4-6 students). Hand out paper to groups (one sheet white paper, one sheet each of two different colors). Have one student in each group draw a large circle with a marker on the white sheet of paper. One of the colored papers represents available fresh water (potable water); the other represents the rest of the water on the planet.

2. Instruct students to tear the two sheets of colored paper into a total of 100 small pieces. Ask them to predict how many pieces will represent potable water and how many pieces will indicate the rest of the water on the planet. Instruct each group to arrange the 100 pieces within the circle so that these pieces reflect their predictions. Have groups record the

California Mathematics Content Standards

Number Sense

1.1. Estimate, round, and manipulate very large (e.g., millions) and very small (e.g., thousandths) numbers.

1.2. Interpret percents as a part of a hundred; find decimal and percent equivalents for common fractions and explain why they represent the same value; compute a given percent of a whole number.

Objectives

Students will:

- Calculate the percentage of fresh water available on Earth for human use.
- Know Earth is covered mainly by water, but that only a small amount is available for human consumption.
- Explain why water is such a limited resource.
- Appreciate the need to use water resources wisely.

Materials

1. Two colors of construction paper for each group of four students
2. Sheets of white paper
3. Markers
4. Water
5. Globe or world map
6. 1000 ml beaker (or a clear 1 liter bottle)
7. 100 ml graduated cylinder
8. Small dish
9. Table salt
10. Freezer, ice bucket, or ice cube tray
11. Eyedropper or glass stirring rod
12. Small metal bucket
13. Photocopies of "Water Availability Worksheet," one per student

Time to complete

One hour

Mode of instruction

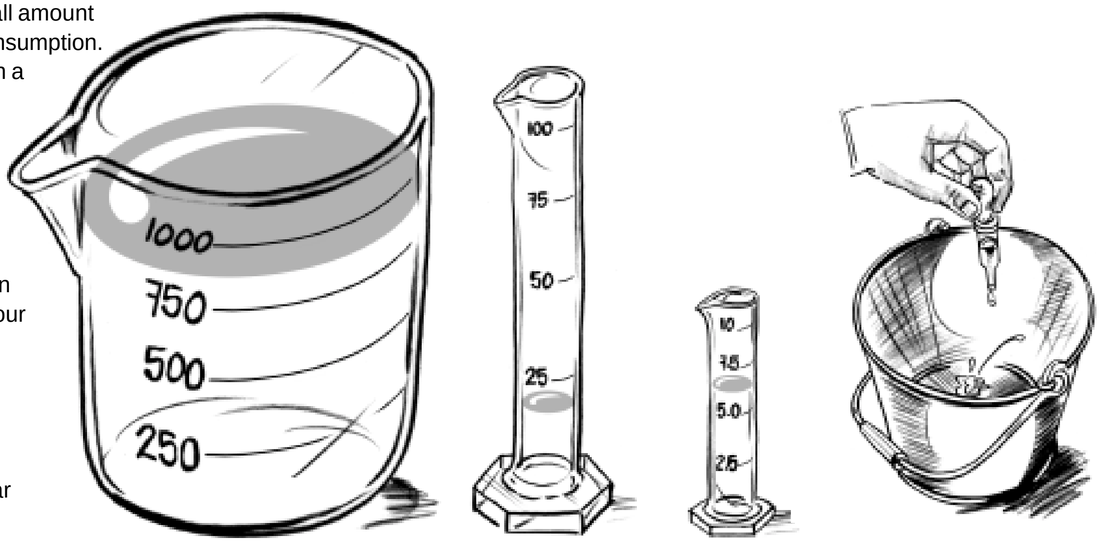
Small group activity followed by teacher demonstration, student worksheet, and whole class discussion.

number of pieces representing "potable" and "remaining" water. Have students translate these numbers into percentages, fractions, and decimals. (If they predict the amount of potable water to be ten pieces of paper out of 100, this is equivalent to 10%, 10/100=1/10, and 0.1.) Students write their numbers on the sheet of paper and set aside for later discussion.

Activity 5.1b
A Drop in the Bucket

1. Set all materials on table in front of students. Show class a liter (1000 ml) of water and tell them it represents all of the water on the planet.

2. Ask students where most of the water on Earth is located (refer to a globe or a map of the world). Pour 30 ml of the water into a 100 ml graduated cylinder. This 30 ml represents Earth's fresh water, about 3 percent of the total amount of water on Earth. Put salt into the remaining 970 ml in beaker to simulate ocean salt water unsuitable for human consumption.



1000 ml (total on Earth) 30 ml (fresh) 6 ml (non-frozen fresh) 0.03 ml (potable)

3. Ask students what is at Earth's poles. (*Almost 80 percent of Earth's fresh water is frozen in ice caps and glaciers.)* Pour 6 ml of the 30 ml of fresh water into a small dish or cylinder and place the rest (24 ml) in a freezer, ice bucket, or ice cube tray. The 6 ml in the dish or cylinder (around 0.6 percent of the total water) represents non-frozen fresh water. Only about 1.5 ml of this water is surface water; the balance is underground, unavailable, or is not potable.

4. Use an eyedropper or a glass stirring rod to remove a single drop of water. Release this one drop into a small metal bucket (one drop equals about 0.03 ml). Students must be very quiet to hear the sound of the drop hitting the bottom of the bucket. This represents clean, fresh water that is not polluted or otherwise unavailable for use, about 0.003 percent (three thousandths of a percent) of the total amount of water on Earth! Write "0.003 %" on the board.

5. Discuss results of demonstration. A very small amount of water on Earth is available to humans.

Preparation

Collect materials. Review concept of percentages with students. This is a fun and relatively easy activity.

Outline

Before class

1. Collect materials the week before
2. Set up for classroom demonstration.
3. Photocopy "Water Availability Table," one per student.

During class

1. Hand out two pieces of white paper and two pieces of different colored paper to each group.
2. Conduct student predicting activity.
3. Conduct teacher-led demonstration.
4. Hand out "Water Availability Table" to each student. Complete worksheet.
5. Whole class discussion on demonstration.
6. Whole class discussion comparing results of student predictions to teacher demonstration.

ANSWER KEY 5.1b Water Availability Table

Total Water (100%) on Earth divided among all people (based on a world population of 6 billion people)
= 233.3 billion liters/person

Minus the 97% of each share (226.3 billion liters) that contains salt (oceans, seas, some lakes and rivers) 233.3 – 226.3 billion liters
= 7 billion liters/person

Minus the 80% of this 7 billion that is frozen at the poles (5.6 billion) 7 – 5.6 billion liters
= 1.4 billion liters/person

Minus the 99.5% of the 1.4 billion that is unavailable (too far underground, polluted, trapped in soil, etc.) (1.393 billion) 1.4 – 1.393 billion liters
= 7 million liters/person

Results and reflection

1. Students retrieve their earlier guesses at how much water on Earth is available to humans, and compare them to actual percent that is available. **A little more than one-half of one of the 100 pieces of colored paper represents potentially available water (0.6 percent.) Only one small corner of this half (0.003 percent) is potable water.** Have students explain their reasoning for their initial predictions. How would they adjust their proportions? Complete "Water Availablity Worksheet."
2. Ask students again if enough water is currently available for people. If the amount of usable water on the planet is divided by the current population of approximately 6 billion, 7 million liters of water is available per person. Theoretically, this exceeds the amount of water an individual would require in a lifetime, but keep in mind that humans use the majority of potable water for industry and agriculture, and that other organisms use water, not just humans.
3. Why does more than one-third of the world's population *not* have access to clean water? Discuss with your class the main factors affecting water distribution on Earth (e.g., land forms, vegetation, proximity to large bodies of water, economics, and politics), and the environmental influences that affect the availability of water (drought, contamination, flooding).

Conclusions

Though 71 percent of the Earth is covered with water, very little of this (0.003 percent) is potable, or usable by humans. We must take care of our fresh water resources to ensure there is enough water for the natural diversity of life on Earth.

Extensions and applications

1. Students develop a television commercial stating reasons why water is a limited resource.
2. Students can identify areas of the globe where water is limited, plentiful, or in excess and discuss the geographical and climatic qualities contributing to these conditions. For example, large variations in precipitation occur within states (Death Valley receives as little as 2 to 5 inches [5 to 12.5 cm] per year. Only 100 miles away, mountain ranges receive more than 30 inches [76 cm] per year. These variations dramatically impact plants, people, and other animals.)
3. Have students bring in newspaper or magazine articles about droughts and floods worldwide; identify the locations on a world map.
4. How would global warming affect the amount of usable water on Earth? (*Polar ice caps would melt, adding more water to the oceans; sea level would rise, putting low lying coastal lands and small islands in danger. Worldwide weather changes would occur, due to global ocean temperature changes.)* What areas of the world would be most affected? (*Low lying coastal areas.*) How would students' lives be changed by melting polar ice caps? (*Weather changes, coastal changes, food production changes, etc.*)

Adapted from

A Drop in the Bucket is used with permission from Project WET/Montana State University from the *Project Wet Curriculum and Activity Guide.* For further information about Project WET (Water Education for Teachers), contact the national office at (406) 994-5392, or the California Project Wet, Water Education Foundation, (916) 444-6240, *www.watereducation.org*

Water Availability Worksheet

How much water is there on Earth? Is it all usable? Is there enough usable water for everyone to have as much as they need? Use this table to calculate how much clean water is available for all our uses.

Quantity to be divided among all people on Earth	Amount available (liters per person)	Percentage of total water
All the water on Earth	233.3 billion	100%
Only the fresh water (calculate 3% of the total amount available)		
Only the non-frozen fresh water (calculate 20% of the remaining amount available)		
Available fresh water that is not polluted, trapped in soil, or too far below ground to use (calculate 0.5% of the remaining amount available)		

1. Where is all this water? Is it distributed equally around the world?

2. How will future population growth affect the amount of water available for us to use?

3. How will our lives be affected if we don’t have enough clean water?

4. What can we do to make sure there is enough clean water in California’s future?

Due to copyright restrictions this activity is not available to you online.

However, you may get it by going to http://www.coast4u.org/waves/waves2.html for our convenient order form.

Grade 5 Activity

Science skills

- Observing
- Predicting
- Hypothesizing
- Analyzing

Concepts

- Water flows through and connects watersheds.
- Wherever you are, you are in a watershed.

California Science Content Standards

Earth Science

3. Water on Earth moves between the oceans and land through the processes of evaporation and condensation. As a basis for understanding this concept, student will know:

3.a. Most of Earth's water is present as salt water in the oceans, which cover most of Earth's surface.

3.d. The amount of fresh water located in rivers, lakes, underground sources, and glaciers is limited and that its availability can be extended by recycling and decreasing the use of water.

3.e. Students know the origin of the water used by their local communities.

Objectives

Students will:

- Investigate drainage patterns.
- Observe how watersheds distinguish different land areas.
- Discover the origin of the water used in their local community.

Time to complete

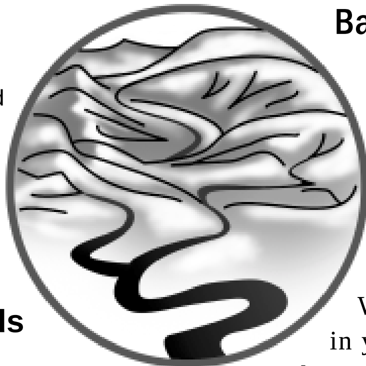
Two 50-minute periods. If making permanent watershed, allow at least three days for materials to dry before conducting experiments.

Mode of instruction

Small group model making followed by experiments and analyses.

Activity 5.3 Branching Out

Where does your water come from? Build a model watershed and predict where the water will travel across the land.



Background

The water cycle is the path water takes through its various states—vapor, liquid, and solid—as it moves through Earth's systems (oceans, atmosphere, ground water, streams, etc.). As we see a rushing stream or a river gushing during a major rainstorm, we may ask, Where does all this water come from? As we watch water flow down a street during a heavy rainstorm, we may ask, Where does all the water go? Answers may be found right in your own neighborhood! No matter how dry it looks, chances are there is water flowing far below your feet. Wherever you are, you are in a *watershed*, the land area from which surface runoff drains into a stream channel, lake, ocean, or other body of water.

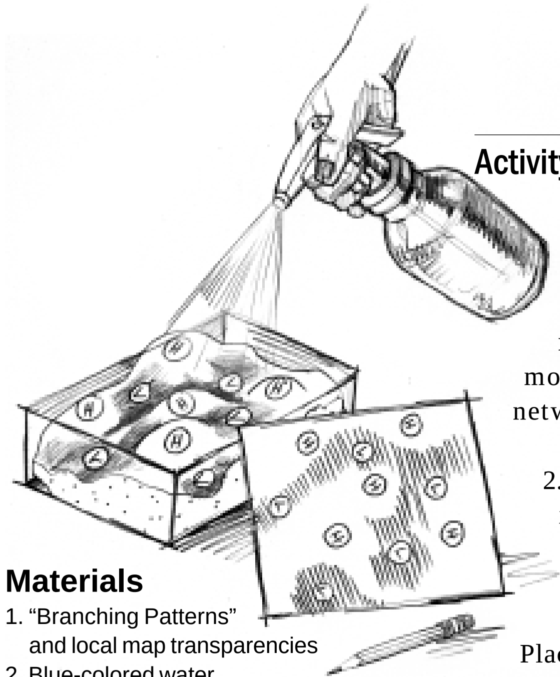
The pattern water makes as it flows through a watershed is familiar to students who have drawn pictures of trees or studied the nervous system. By investigating drainage patterns, we can better understand how watersheds distinguish different land areas.

When the ground is saturated or impermeable to water (when water cannot soak into the ground) during heavy rains or snowmelt, excess water flows over the surface of land as runoff. Eventually this water collects in channels such as streams. Watersheds are known by the major streams and rivers into which they drain.

Watersheds are separated from each other by areas of higher elevations called ridge lines or divides. Near the divide of a watershed, water channels are narrow and can contain fast-moving water. At lower elevations, the slope of the land decreases, causing water to flow more slowly. Eventually, water collects in a wide river that empties into a body of water, such as a lake or ocean.

From a bird's eye view, drainage patterns in a watershed resemble a network similar to the branching pattern of a tree. Tributaries, similar to twigs and small branches, flow into streams, the main branches of the tree. Like other branching patterns (e.g., road maps, veins in a leaf), the drainage pattern consists of smaller channels merging into larger ones.

Watersheds are either closed or open systems. In closed systems, such as Mono Lake in northeast California, water collects at a low point that lacks an outlet. The only way water leaves is by evaporation or seeping into the ground. Most watersheds are open—water collects in smaller drainage basins that overflow into outlet rivers and eventually empty into the sea.



Materials

1. "Branching Patterns" and local map transparencies
2. Blue-colored water
3. Spray bottles or sprinkling cans, one for each model
4. Drawing paper and pencil
5. Blue pencils
6. Tracing paper or blank transparency sheets
7. Photocopies of a local map showing rivers (watersheds also if available), one for each student
8. Overhead projector

Note: Students may build a temporary, simpler model, or a durable version that can be used for further experiments. Materials for both are listed here.

For both models

1. Five to ten rocks, ranging from 2 to 6 inches (5 to 15 cm) in height. If groups of students are making their own models, each group will need its own rocks.
2. Square or rectangular aluminum tray, large enough to hold rocks. A large disposable baking or turkey roasting pan will work.
3. Plastic wrap (thick plastic wrap from a grocery or butcher shop works best).

For temporary model

White scrap paper, newsprint, or butcher paper

For permanent model

<u>Note: Allow extra time to make this model</u>. Begin it at least three days before the experiments are to be conducted—the papier-mâché needs to dry overnight, and then the paint needs time to dry completely.

1. Papier-mâché materials (strips of newspaper dipped in a thick mixture of flour and water)
2. Water-resistant sealer and white paint (or white waterproof paint)

Activity

1. Ask students what they know about watersheds. Is there one near their home? (*Trick question: Wherever you live, you are in a watershed, even if that watershed is covered with asphalt.*) What is in a watershed? How can you tell one from another? Can you name a local watershed? Tell students they are going to build a model of a watershed to see how water flows through a branching network of drainages.

2. Depending on whether a temporary or more permanent model is being built, students will do the following:

Temporary model

Instruct students to select six rocks and wrap them with white scrap paper. Lay them in a square or rectangular aluminum tray. Place larger rocks near one end of the tray. Cover the paper-covered rocks with plastic wrap.

Permanent model

Instruct students to lay rocks in a square or rectangular aluminum tray, with larger rocks near one end. Snugly cover the rocks and exposed areas of the tray with plastic wrap. Apply strips of papier-mâché to cover the rocks. For a studier model, apply several layers of papier-mâché. When the mâché has dried, coat the model with white paint and waterproof sealant, or waterproof white paint.

3. Students will sketch a bird's eye view of the model. They should mark points of higher elevations with "H"s and low spots with "L"s. To identify possible ridgelines, connect "H"s.

4. Tell students the model will soon experience a rainstorm. Where do they think water will flow and collect in the model? Have them sketch their prediction on their drawings. Indicate the crevices in their models and possible locations of watersheds.

5. Students will spray blue-colored water over the model and note where it flows. Water may need to be sprayed for several minutes to cause a continual flow. Assist students in identifying branching patterns as water from smaller channels merges into larger streams.

6. Students will use blue pencil to mark on their drawings the actual branching patterns of water. Some imagination and logic may be required. Ask them to confirm the locations of watersheds by noting where water has collected in the model.

7. Ask students to determine if smaller watersheds overflow into larger ones. Does all the water in the model eventually drain into one collection site (open watershed system)? Does the model contain several closed water systems (collection sites that lack an outlet)?

8. Students will place tracing paper or an overhead transparency over their drawings and draw the drainage patterns. Groups compare and contrast each other's drawings. Discuss how the networks of smaller channels merge together to become larger.

Preparation

Collect materials, photocopy transparencies and maps, build models, and keep a space open in the room for the models to be worked on and displayed.

Outline

Before class:

1. Decide whether you will build the more durable and permanent watersheds or the lighter and more fragile temporary watersheds. Purchase or have students bring in appropriate materials (see list) based on this decision.
2. Have students bring in all other materials (rocks, blue pencils).
3. Photocopy map of the area around your school, with rivers and streams. One copy for each student.
4. Photocopy onto overhead transparency "Branching Patterns" sheet.

During class

1. Show overhead transparency of "Branching Patterns."
2. Arrange students into small groups of 3-4 students.
3. Using sample model making materials, illustrate how to make the model.
4. Distribute materials to each group.
5. Oversee model manufacturing (depending upon which model you choose, assembling the model will be completed in one day or over a series of days).
6. Allow students to proceed with experiments, roving from group to group to assist.
7. Whole class discussion on watersheds.

9. Hand out photocopied maps of local area with streams, rivers, and lakes. Students locate streams and rivers and draw a circle around land areas they think drain into the river.

10. Students pick one river on the map and follow its path in two directions (upstream and downstream). If the entire river is pictured, one direction should lead to the headwaters or source, and the other direction merge with another river or empty into a body of water.

Results and reflection

1. Students predict where water will flow and collect in watershed model, and write their predictions on a piece of paper.
2. Students test their predictions and use the results to confirm or modify their projected drainage patterns.
3. Students will compare the drainage pattern of watersheds to other branching networks.
4. Students write a story about or draw a map of drainage patterns in their watershed. Label mountains, rivers, streams, reservoirs, lakes.

Conclusions

Watersheds have a branching pattern that distributes water from rain and snow into streams, rivers, and lakes. Water moves from high to low areas, collecting in drainage basins. These drainage basins are the source of water for most of our communities.

Extensions and applications

1. If the model were a real land area, would the drainage patterns be the same thousands of years from now? Students should consider the effects of natural and human-introduced elements (e.g., landslides, floods, erosion, evaporation, water consumption by plants and animals, runoff from agricultural fields, droughts, dams). Have students write one page describing what the future watershed looks like.
2. Students may finish their models by painting landscapes and constructing scale models of trees, wetlands, and riparian areas. Introduce human influences, such as towns and roads.
3. As in the game "Pin the Tail on the Donkey," blindfold students and have them randomly touch a point on a map of California. Have students explain likely routes water would take in that area. Where is the closest large river? Lake? Ocean? Are there dams on the river?
4. Students may make a topographic map of their model. First, they totally waterproof the model. Next, they submerge it, one-half inch at a time, in water. At each increment, while viewing from above, they trace the water level onto a sheet of glass or clear plastic held over the model. Students can make elevation lines and draw the map true to scale.

Adapted from

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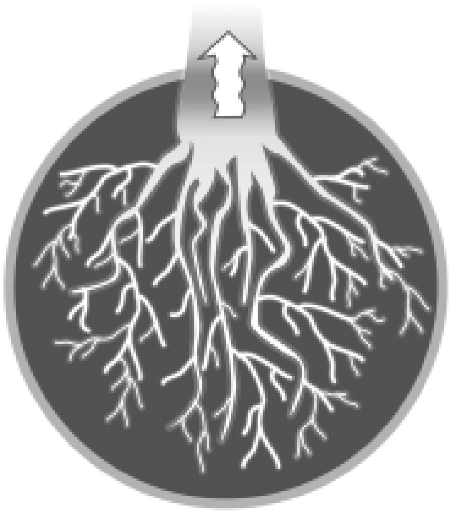
Other References

Project GLOBE. www.globe.gov

Branching Patterns

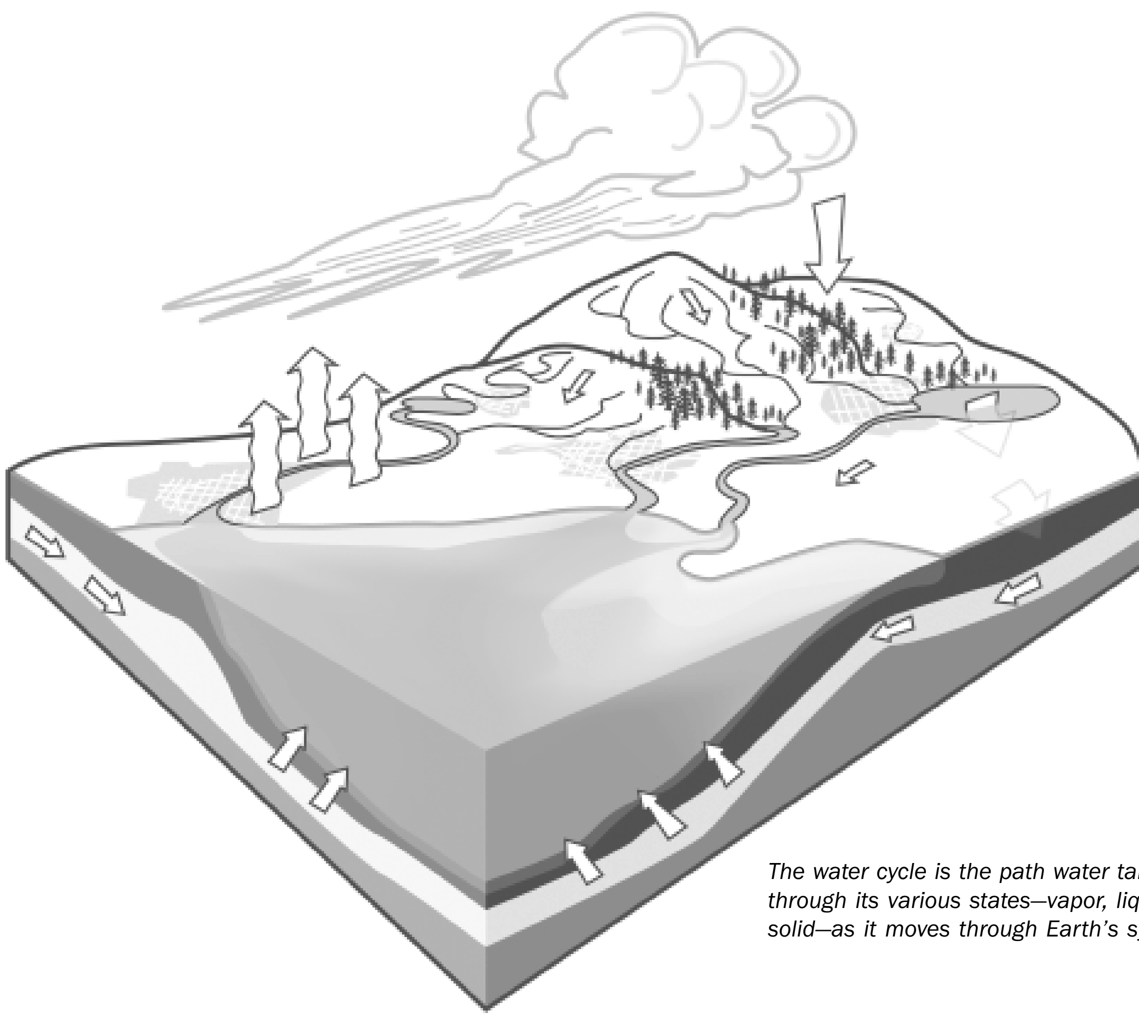


SECONDARY ROOTS FEEDING
PRIMARY TREE ROOTS

TRIBUTARIES FEEDING
MAIN WATERWAY

WATERSHED

The Water Cycle



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Notes